

A Clinical Analysis of 32 Brainstem Haemorrhages; with Special Reference to Surviving but Severely Disabled Cases

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Summary

Thirty-two patients with CT-documented primary brainstem haemorrhage were reviewed retrospectively to obtain a clearer overall clinical picture, especially of the severely disabled survivors. They were divided into 3 groups according to outcome: eleven cases (Group 1) died within 1 month following haemorrhage, 11 cases (Group 2) survived but became bedridden, necessitating full living support, and 10 cases (Group 3) showed minimal neurological deficits and resumed normal activities. Owing to CT and improved critical care, the survival rate was 66% for the whole series. Group 2 comprised 34% of all cases. These patients were mostly alert, quadriplegic, and communicated only with great difficulty.

The most common initial symptoms and CT finding in each group were as follows; *Group 1*: unconsciousness, respiratory disturbance, negative light reflex, tachycardia, and haematoma >3.0 cm; *Group 2*: disturbance of consciousness, respiratory disturbance, positive light reflex, normal heart rate, and 2.0 > haematoma <3.5 cm; and *Group 3*: alertness or only slight disturbance of consciousness, normal respiration, positive light reflex, normal heart rate, haematoma <2.5 cm. Although there is an overlap among them, these findings will be useful to distinguish the three groups from each other. Patients with disturbance of consciousness, respiratory disturbance, positive light reflex, normal heart rate, and 2.0 > haematoma <3.5 cm, have a chance to survive, but in severely disabled condition, if they were treated with vigorous intensive care in the acute stage.

Keywords: Brainstem haemorrhage; CT scan; outcome.

Introduction

Before the advent of x-ray computerized tomography (CT), brainstem haemorrhage (BSH) was long thought to be fatal and the diagnosis was usually made based on the clinical picture or by autopsy^{2, 3, 14}. The widespread use of CT led to the recognition that there were many cases in which BSH had a favourable prognosis, sometimes resulting only in minimal neurological deficit^{1, 7–12, 17}. With the improvement of critical care

in the acute stage and modern diagnostic modalities, some patients who formerly would have had unfavourable prognoses could now survive. This created another problem, however, in that some of the survivors were left in an extremely poor neurological state, i.e., clear consciousness yet with quadriplegia and communication disabilities, necessitating full life support.

Thirty-two cases of BSH were reviewed retrospectively with special reference to these surviving but severely disabled patients.

Materials and Methods

Thirty-two patients with CT documented primary BSH (20 males and 12 females) were admitted to our clinic during the past 4 years. Their ages on admission ranged from 40 to 82 years, with a mean of 60. In each case the diagnosis of BSH was made by CT immediately after admission. Patients with neoplasms, trauma, vascular malformations and coagulopathies were all excluded by the clinical picture, laboratory data and CT. Angiography was not performed in any of the cases. The data of admission was immediately after bleeding in all but two cases, who were admitted on the second and third day following the haemorrhage. All but 4 of the 32 patients were treated conservatively. In 3 of these 4 cases, ventricular drainage was carried out in the acute stage, and in the remaining case a ventriculo-peritoneal shunt was inserted in the chronic stage.

The patients were divided into three groups according to the outcome (Table 1). Cases in Group 1 were those who died within 1 month after the ictus, and patients in Groups 2 and 3 were those who survived more than 1 month. Group 2 consisted of those who

Table 1. *Classification of Brainstem Haemorrhages*

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|---|
| Group 1: death within one month |
| Group 2: survival, alert, bedridden, quadriplegia, dependent |
| Group 3: survival, no or minimum neurological deficit, recovery with independence |

Table 2. Summary of Initial Physical and Neurological Signs

| | Group 1 (11 cases) | Group 2 (11 cases) | Group 3 (10 cases) |
|---------------------------------|---|---|-------------------------------|
| Consciousness | coma: 11 | coma: 8 somnolent: 2 alert: 1 | somnolent: 2 alert: 8 |
| Hypertensive history | 8 | 9 | 6 |
| Systolic blood pressure (mm Hg) | 203 | 194 | 200 |
| Body temperature | 38.0 | 37.4 | 36.4 |
| Heart rate (/min) | 110 | 86 | 77 |
| Respiratory disturbance | 9 | 8 | 0 |
| Light reflex | negative: 9 positive: 2 | negative: 2 positive: 9 (sluggish: 3) | positive: 10 (sluggish: 1) |
| Pupillary size | anisocoria: 4 dilated: 3 miotic: 3 normal: 1 | anisocoria: 3 miotic: 3 normal: 5 | anisocoria: 1 normal: 9 |
| Motor function & posture | quadraplegia: 6 decerebrated: 4 decorticated: 1 | quadraplegia: 6 hemiplegia: 3 decerebrated: 2 | hemiplegia: 6 normal: 4 |

were bedridden at the final follow-up. Cases in Group 3 were those who were alert, with no or only minimum motor disturbance necessitating minimal or no help for their daily living activities at the final follow-up. The follow-up periods for Groups 2 and 3 ranged from 1.5 to 48 months, with an average of 19 months.

The patients' level of consciousness, history of hypertension, systolic blood pressure, body temperature, heart rate, respiratory disturbance, pupillary response to light, pupillary size, motor function and posture, CT findings on admission, and the outcome were all reviewed retrospectively.

The CT scanner used was a DR-3 (Siemens Medical, West Germany) with 0.8 cm thick slices spaced at 0.2 cm intervals. Thus, one slice could be regarded as covering 1.0 cm. The number of slices on which the haematoma was visible, the maximum transverse diameter and the longitudinal diameter in cm were measured on CT films.

Midbrain involvement, ventricular haemorrhage, subarachnoid haemorrhage, acute hydrocephalus, and the location of the haematoma in the brainstem were reviewed along with the haematoma size.

Results

Clinical symptoms and outcome (Table 2)

Groups 1, 2 and 3 comprised 11, 11 and 10 cases, respectively. The duration from bleeding to death in Group 1 ranged from 4 hours to 15 days, with a mean of 3 days. In Group 2, two patients were left in a vegetative state while the remaining nine patients became alert but remained quadraplegic and bedridden, and had great communication difficulty. The recovery of consciousness in Group 2 required from 7 to 48 days, with a mean of 32 days, except for two patients left in a vegetative state. Eight patients in Group 3 were

alert on and after admission. The remaining two somnolent patients became alert soon after admission. A tracheostomy was performed in all but one cases in Group 2, this case dying 1.5 months later due to hepatoma. None of the patients in either Group 1 and 3 underwent a tracheostomy. A gastrostomy was performed on 4 cases in Group 2: the remaining 7 were tube-fed. No patient in either Group 1 and 3 had a gastrostomy or was tube-fed.

1. Initial level of consciousness. All patients in Group 1 were comatose on admission. Eight patients in Group 2 (73%) were comatose; the remaining two were somnolent and one was alert. Eight patients in Group 3 (80%) were alert and the remaining two were somnolent.

2. History of hypertension. Twenty-three patients (72%) had a history of hypertension, including 8 (73%) in Group 1, 9 (82%) in Group 2, and 6 (60%) in Group 3.

3. Systolic blood pressure. Systolic blood pressure ranged from 154 to 230 mm Hg (mean 203) in Group 1. In Group 2 it ranged from 160 to 250 mm Hg (mean 194) and in Group 3 from 148 to 258 mm Hg (mean 200).

4. Body temperature. Body temperature used here was measured on admission, usually within 1 hour after arrival and before the administration of antipyretics. In Group 1, body temperature ranged from 35.0 to 40.0 °C (mean 38.0 °C) and in 4 of the 11 patients (36%)

Table 3. Summary of CT Findings

| | Group 1 (11 cases) | Group 2 (11 cases) | Group 3 (10 cases) |
|----------------------------|--------------------|--|--|
| Haematoma size | | | |
| slices | 3.5 | 2.7 | 1.8 |
| transverse diameter (cm) | 3.9 | 3.1 | 2.1 |
| longitudinal diameter (cm) | 2.7 | 2.2 | 1.4 |
| Midbrain involvement | 8 | 8 | 1 |
| Ventricular rupture | 5 | 4 | 0 |
| Subarachnoid haemorrhage | 3 | 2 | 0 |
| Hydrocephalus | 2 | 4 | 0 |
| Laterality | bilateral: 11 | bilateral: 8 unilateral: 3 | bilateral: 5 unilateral: 5 |
| Location | central: 11 | central: 7 tegmental: 3 basal: 1 | central: 2 tegmental: 3 basal: 5 |

it was over 39.0°C. In Group 2 it ranged from 36.0 to 40.6°C (mean 37.4°C) and was over 39.0°C in only two patients (18%). In Group 3, it ranged from 35.2 to 36.8°C (mean 36.4°C) and in no patient was it over 37.0°C.

5. *Heart rate.* In Group 1, the heart rate ranged from 82 to 156 beats per minute (mean 110). In Group 2 it ranged from 60 to 108 (mean 86) and in Group 3 from 60 to 92 (mean 77), with no patient in Group 3 having a rate over 100.

6. *Respiratory disturbance.* Respiratory disturbance on admission was observed in 9 cases in Group 1 (82%) and 8 cases in Group 2 (73%). On the other hand, no patient in Group 3 had respiratory disturbances.

7. *Light reflex of the pupils.* Nine cases in Group 1 (82%) showed negative light reflex in at least one eye. In Group 2 the light reflex was prompt in 6 cases, sluggish in 3 cases and negative in at least one eye in 2 cases. In Group 3 it was brisk in all but one case, in which it was sluggish.

8. *Pupillary size.* In Group 1, bilaterally dilated pupils were observed in 3 cases, anisocoria in 4, and miotic pupils in 3. In Group 2, anisocoria was observed in 3 cases, miotic pupils in 3, and normal-sized pupils were noted in the remaining 5. In Group 3, anisocoria was found in one case and the remaining 9 all had normal-sized pupils. Thus, abnormal pupils (anisocoria, dilated or miotic pupils) were noted 91%, 64% and 10% of the cases in Groups 1, 2 and 3, respectively.

9. *Motor function and the posture.* In Group 1, 4 patients displayed a decerebrate posture (extension of all extremities) and a decorticate posture (flexion of the upper but extension of the lower extremities) was noted in another case. The remaining 6 patients were

quadruplegic. In Group 2, two patients displayed a decerebrate posture, six patients were quadruplegic and the remaining three were hemiplegic. In Group 3, six patients were hemiplegic, but the remaining four had normal motor function. No patient in Group 3 displayed abnormal posture nor quadruplegia. Thus, either an abnormal posture or quadruplegia was noted in 100%, 73% and 0% of the cases in Groups 1, 2 and 3, respectively.

CT findings and outcome (Table 3, Figs. 1–3)

1. *Haematoma size.* In Group 1, the average number



Fig. 1. A case representative of Group 3. This is the CT of a 57-year-old male with a history of hypertension. On admission he was alert and pupils were anisocoric, with the left pupil sluggishly reactive and the right one briskly reactive to light. He had mild right hemiparesis and respiration was normal. Heart rate was 92/minute. Body temperature was 36.2°C and blood pressure was 230/130 mm Hg. The haematoma on the CT measured 3.1 × 1.4 cm and was visible on 2 slices without midbrain involvement. At the latest follow-up after 38 months, he was alert with minimal right hemiparesis and was completely independent

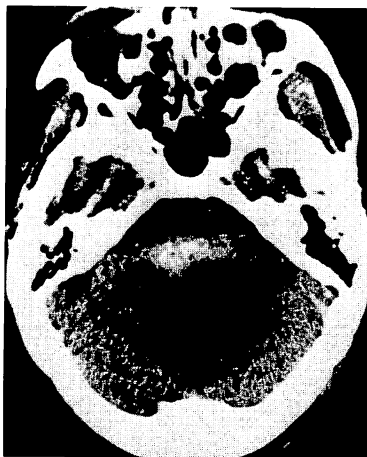


Fig. 2. A case representative of Group 2. This is the CT of a 47-year-old female with a history of hypertension. Her initial level of consciousness was comatose, and her pupils were miotic bilaterally and reactive to light. She was quadriplegic and respiration was irregular and ataxic. Heart rate was 84/minute. Body temperature was 39.6 °C and blood pressure was 220/140 mm Hg. The haematoma on the CT measured 4.1 × 2.0 cm and was visible on 2 slices without midbrain involvement. She survived the acute stage under controlled ventilation for 13 days and on the 14th day she returned to almost alert. After a follow-up period of 9 months she was alert but quadriplegic and completely bedridden, requiring full daily life support



Fig. 3. A case representative of Group 1. This is the CT of a 59-year-old female with a history of hypertension. On admission immediately after ictus she was comatose with anisocoric pupils non-reactive to light. The patient's posture was decerebrate to painful stimuli and respiration was ataxic. Heart rate was 156/minute. Body temperature was 38.0 °C and blood pressure was 180/110 mm Hg. The haematoma on the CT measured 3.1 × 2.0 cm and was visible on 3 slices with midbrain involvement. She died 4 hours after admission

of slices, in which the haematoma was visible, the transverse diameter and the longitudinal diameter were 3.5, 3.9 and 2.7 cm, respectively. In Group 2, they were 2.7,

3.1 and 2.2 cm, respectively. In Group 3 they were 1.8, 2.1 and 1.4 cm. In all of the patients in Group 1, the haematoma was visible on at least 3 slices. In Group 3, the haematoma was visible on 2 slices at the most. Regarding the size of the haematoma, Group 2 was between Groups 1 and 3 and the number of slices in which the haematoma was visible ranged from 1 to 4.

2. *Midbrain involvement.* Midbrain involvement of the haematoma was noted in 8 cases in Group 1 (73%), 8 in Group 2 (73%) and one in Group 3 (10%), respectively.

3. *Ventricular haemorrhage.* Ventricular haemorrhage was noted in 5 cases in Group 1 (46%), 4 in Group 2 (36%) and none in Group 3.

4. *Subarachnoid haemorrhage.* Subarachnoid haemorrhage was noted in 3 cases in Group 1 (27%), 2 in Group 2 (18%) and none in Group 3.

5. *Hydrocephalus.* Acute hydrocephalus was noted on the initial CT in 2 cases in Group 1 (18%), 4 cases in Group 2 (36%) and none in Group 3.

6. *Location of the haematoma.* In all cases in Group 1, there were large haematomas located centrally and bilaterally in the brainstem. In Group 2, seven patients had bilateral central haematomas, and one had a bilateral tegmental haematoma. One patient had a unilateral basal and two had unilateral tegmental haematomas. In Group 3, there were 2 bilateral central haematomas, 3 bilateral basal haematomas, 2 unilateral basal haematomas and 3 unilateral tegmental haematomas. Thus, there were bilateral lesions in all cases (100%) in Group 1, 8 cases (73%) in Group 2 and 5 cases (50%) in Group 3.

Discussion

The "classical" picture of BSH consists of coma, respiratory disturbance, quadriplegia, hyperthermia, abnormal pupils and a fatal outcome^{2, 3, 14}. Presently, with the widespread use of CT, considerable heterogeneity in the prognosis is well recognized^{1, 7, 8, 10-12, 15, 17}. Magnetic resonance imaging now enables precise radiological evaluation of BSH in the subacute and chronic stages for the survival group⁵. Auditory evoked potential in the chronic stage is also useful for prognostic prediction¹⁷.

Prior to the advent of CT, BSH patients usually died within 1 week. Mainly because of the difficulty in diagnosing BSH with favourable prognoses, BSH was diagnosed only in the fatal group at that time. The survival rates recently reported for BSH are 28%¹¹, 31%¹⁵, 49%¹⁷ and 75%⁸. The survival rate in this series

was 66%, and the survival rate with a meaningful recovery (Group 3) was 31%. Our rate of survival with a meaningful recovery was higher than those reported previously. This can be attributed to improved diagnostic modalities, such as CT, and to critical care in the acute stage.

A history of hypertension has been documented in 60–80%^{8, 11, 17} of cases of BSH, but no significant difference has been found with respect to a fatal or non-fatal prognosis¹¹. In the present series, hypertension was noted in 72% of the total cases without significant differences among the three groups.

Some BSH patients die immediately after bleeding and others recover sufficiently to live meaningful lives with almost no neurological deficit. However, there is a group of surviving patients who fall between the two groups mentioned above regarding their clinical picture. The patients in this group are severely disabled and require full support for their activities, primarily due to quadriplegia and communication disabilities.

A good prognosis was found when there was little or no disturbance of consciousness, normal pupils³, and motor disturbance was limited to hemiplegia without decerebrate posture¹¹. A poor prognosis was found in comatose patients with bilaterally dilated pupils, pinpoint pupils or anisocoria¹⁰, who were quadriplegic¹¹. However, the level of consciousness was not always predictable of the outcome¹. In this series, the patients in Group 1 commonly were comatose and displayed such symptoms as hyperthermia, tachycardia, respiratory disturbance, negative light reflex, dilated or anisocoric pupils, and abnormal posture or quadriplegia. On the other hand, the patients in Group 3 were alert and displayed normothermia, normal heart rate, normal respiration, positive light reflex and normal-sized pupils, and none had abnormal posture or quadriplegia. The patients in Group 2 were between Groups 1 and 3 as far as symptoms were concerned. They commonly were comatose or somnolent and displayed normal heart rate, respiratory disturbance, positive light reflex, miotic or normal-sized pupils, and had either abnormal posture, quadru- or hemiplegia.

Tanaka *et al.*¹⁵ classified CT findings of BSH into massive, basis tegmentum and tegmentum types. The latter two were further divided into unilateral and bilateral subtypes. Patients with massive type were mostly fatal, whereas the basis tegmentum and tegmentum types were not fatal. Patients with the basis tegmentum type and bilateral lesions had a poor functional prognosis, even if they survived. Cases of the tegmentum type (both unilateral and bilateral subtypes) had a fairly

good prognosis. A good prognosis was also reported by Kushner and Bressman⁷ in patients with two types of unilateral haematoma, i.e., in the unilateral basis pontis and tegmentum type and in the unilateral tegmentum type. In our cases, patients in Group 1 all had bilateral, large centrally located haematomas and no unilateral lesions were noted. Seven of the 11 cases in Group 2 had bilateral, centrally located haematomas and 3 cases had unilateral haematomas. Five of the 10 cases in Group 3 had a unilateral lesion, while 5 cases had bilateral lesions.

Regarding the size of the haematomas, a good prognosis was found in patients with haematomas measuring 2.0 cm or less in diameter¹⁰, less than 1.0 cm¹² and less than 2.0 cm with the haematoma appearing on not more than 2 slices⁸. On the other hand, a poor prognosis was found in patients with a haematoma over 2.0 cm in diameter¹⁰, over 1.0 cm¹², and more than 3.1 cm with the haematoma appearing on at least 4 slices⁸. Koga *et al.*⁴ reported that a maximum diameter of 2.0–2.5 cm could be roughly used to divide the prognosis between good and poor. Contrary to these reports, Del-Brutto *et al.*¹ concluded that the size of the haematoma was not always predictable of the outcome. In Group 1 in this series, the diameter of the haematoma was usually more than 3.0 cm and the number of its slices on which it was visible was not less than 3 with midbrain involvement. In Group 2, the diameter of the haematoma was usually more than 2.0 cm and less than 3.5 cm, with the number of slices on which it appeared was ranging from 1 to 4 with midbrain involvement and ventricular haemorrhage. In Group 3, the diameter of the haematoma was less than 2.5 cm and the number of slices on which it appeared was not more than 2. In this group there was no midbrain involvement or ventricular haemorrhage.

Subarachnoid haemorrhage in young, normotensive patients suggests a ruptured vascular malformation and angiography is indicated¹⁶. Although subarachnoid haemorrhage was noted in 5 cases in this series, however, angiography was not carried out in any of the cases. Despite some possibility that these cases might have vascular malformations, primary BSH was considered most likely since all of the patients were middle-aged or older and had a history of hypertension.

Regardless of whatever treatment is employed, the prognosis for patients with the following symptoms and CT findings is invariably fatal: disturbance of consciousness, respiratory disturbance, negative light reflex, tachycardia, and a haematoma > 3.0 cm. In contrast, conservative treatment leads to good results in

patients with a clinical picture of alertness, normal respiration, positive light reflex, normal heart rate, and haematoma <2.5 cm. The problem is deciding on a course of treatment for patients with those of disturbance of consciousness, positive light reflex, normal heart rate, and haematoma size between 2.0 and 3.5 cm. Owing to recent advances in critical care, especially respiratory therapy, the prognosis for this group has changed from death to survival, but with severe disability.

There have been several isolated reports of successful surgical removal of BSH, but these have usually been in normotensive, young patients^{6,13}. Surgical therapy is not generally recognized as being superior to conservative therapy for BSH. Even if surgery is thought viable, the overwhelming likelihood of an unsatisfactory outcome should be strongly considered. At present, the authors think that there is no place for surgical removal of the haematoma in the treatment of BSH.

In conclusion, the most likely result will be severely disabled survivors with a poor prognosis if patients with the following symptoms and CT findings were treated with vigorous supportive care in the acute stage: disturbance of consciousness, respiratory disturbance, positive light reflex, normal heart rate, and haematoma size between 2.0 and 3.5 cm.

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